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ABSTRACT

The nine units in the curriculum guide on energy options focus on energy from coal, the sun, petroleum, the wind, water, and trees; and on heat pumps, energy conservation, and agriculture and energy. The units are comprised of from two to seven lessons. Each lesson contains objectives, approximate time, procedure, evaluation questions or methods, a list of further activities, and resource information. The units, designed for grades K-12, are illustrated with black and white drawings. The guide contains a list of energy curriculum materials sources. (SB)

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CURRICULUM RESOURCES

FOR THE

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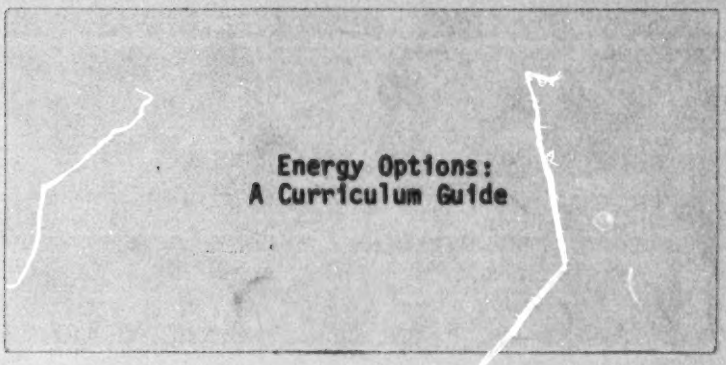

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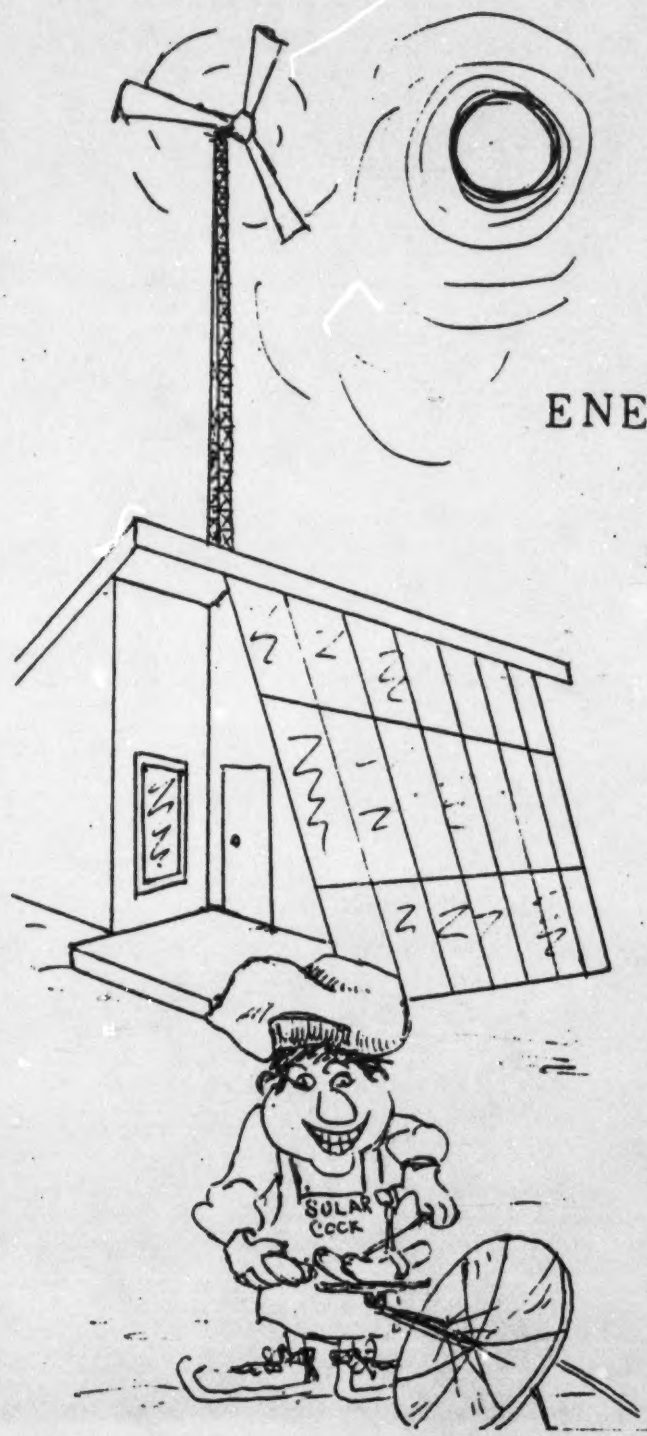

ENERGY OPTIONS:

A

CURRICULUM

GUIDE

University of Alaska, Fairbanks
1982 Summer Sessions Workshop

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UNIT I. What Is Coal?

A. Understanding the Four Basic Types of Coal
   1. Objective: After this lesson, student will be able to identify the four major types of coal.
   2. Approximate Time: One class period.
   3. Procedures:
      a) teacher has four examples of coal and explains each.
B. Utilization of Coal
C. Environmental Problems
D. Methods of Mining Coal
E. Coal Terminology

Four Major Coal Types

Coal Rank - This classification is based on fixed carbon, volatile matter, and heating value. It is an indication of the progressive alteration, or coalification, from lignite to anthracite.

1. Lignite - the lowest rank of coal, is brownish black and has a high moisture content, and is used mainly to generate electricity. It is mined in North Dakota, Montana, and Texas.

2. Subbituminous Coal, or black lignite, is dull black. It is used for generating electricity and space heating. This rank of coal is mined in the western coal fields.

3. Bituminous Coal or soft coal is the most common coal. It is dense, black, often with well-defined bands of bright and dull material, and is used for generating electricity, making coke, and space heating. The ignition temperature is 700 degrees to 800 degree Fahrenheit. Bituminous coal is mined chiefly in the Appalachian and Interior coal fields.

4. Anthracite, or hard coal, is the highest rank of coal. It is hard, jet black, with a high luster and is used for generating electricity and space heating. Its ignition temperature is about 900 degrees Fahrenheit. Anthracite is mined in northern Pennsylvania.

Coal Type: this classification is based on physical characteristics or microscopic constituents (for example, bright coal, splint coal, cannel coal).

Grade of Coal: in general, this refers to coal quality with regard to use. Metallurgical coal (or coking coal). Steam coal is best suited for generating steam to produce electricity or for other purposes. Low-sulfur coal generally contains one percent or less sulfur by weight. Cleaned coal has been processed to reduce the amount of impurities present and improve the burning characteristics.

5. Evaluation:

   1. What is the hardest coal of the four varieties presented in this lesson?

2. Which coal has the highest energy content?
3. Which coal has the highest sulfur content?
4. Which coal is the most abundant?
5. Which coal is the rarest and most valuable of the four varieties presented?
6. Which coal types are most easily mined using strip mining techniques?
7. Teacher evaluation.

6. Further activities -
   1. Slides
   2. Visiting a coal mining site
   3. Burning small equal quantities of each type of coal
   4. Film: Living With Energy - Bullfrog film

7. Resources -
   1. U.S. Geological Map of major coal fields - U.S. Geological Survey-Fairbanks
   2. Coal books: a) Coal Data: A Reference, July 1980, USDOE; b) Energy Future, 1979, by Robert Stobaugh
   3. Information: a) National Coal Association, Washington, D.C.

B. Utilization of Coal

1. After this lesson, student will be aware of the importance of the utilization of coal as an energy source. (Heating power, generation, manufacturing of synthetics).

2. Approx. Time: one week to two weeks.

3. Procedures:
   a) An introductory lesson of why coal is being reintroduced as an energy source.
      1. One ton of coal is equal to one cord of seasoned hardwood.
   b) Students will be able to compare a mass of 1 ton of coal to one cord of hardwood.
      1. Experiment: students will determine the cubic footage of one cord of wood.
      2. Students will weigh one cubic foot of dry wood and, therefore, will determine weight of one cord of wood.
      3. Same procedure will be determined for coal.
   c) Students will be able to compare heating qualities of coal vs. wood.
      1. Experiment: students will weigh out proportional amounts of coal and wood in order to learn burning qualities and quantities needed to heat water to the boiling point.
   d) Students will be able to understand the various layers in soils.
      1. Experiment: students will go on a field trip to see soil layers. These can be observed at an excavation site or along a cut bank in a stream or road. The teacher can explain the coal is found in layers in soil also.

4. Evaluation:
   a) Students will be able to determine for themselves what is best

utilization of coal for future reference.

b) Teacher evaluation.

5. Further Activities:
   a) Slides
   b) Bar graphs using opaque projector
   c) Individual or group problem solving techniques

6. Resources:
Coal books: a) Coal Data: A Reference, July 1980, USDOE: b) Energy Future, 1979, by Robert Stobaugh; c) Supplementary Energy Sources, by Amoco

C. Environmental Problems

1. After this lesson student will be aware of the importance of environment problems.

2. Approx. Time: one week to two weeks.

3. Procedures:
   a) An introductory lesson of why coal has some environmental problems.

      1. Experiment: students will burn coal and wood separately in a contained area. Determine sulphur smell and pot ash.
      2. Experiment: students will burn approximately equal quantities of coal and wood in a confined area to determine which has the most heat and which sample burns the longest. Determine which gives off the highest initial amount of heat and which sample burns longest.

4. Evaluation:
   a) Students will be able to determine for themselves what is best from an environmental viewpoint.
   b) Teacher evaluation.

5. Further Activities:
   a) Individual or group problem solving techniques
   b) Study of black lung disease
   c) Study of power plants
   d) Study of acid rain
   e) Study the Clean Air Act of 1977

6. Resources:
Coal books: a) Coal Data: A Reference, July 1980, USDOE; b) Energy Future, 1979, by Robert Stobaugh.

D. Methods of Mining Coal

1. After this lesson, student will be aware of the various methods of mining coal.

2. Approx. Time: one week.

3. Procedures:

a) An introductory lesson of various methods of mining coal

1. Teacher will explain types of mines by showing slides and pictures.

a) A drift mine is driven horizontally into coal exposed or accessible in a hillside.

b) A shaft mine is driven vertically to the coal deposit.

c) A slope mine is driven at an angle to reach the coal deposit.

d) In a room-and-pillar mining system, the most common method, the mine roof is supported by coal pillars left at regular intervals. Rooms are places where the coal is mined; pillars are areas of coal left between the rooms.

e) In a longwall mining system, large sections of coal are removed and no pillars are left to support the mined out areas, the caved area (gob) compacts and, after initial subsidence, supports the overlying strata.

f) A shortwall mining system in general, combines room-and-pillar operations with small-sized longwall operation.

g) In an open pit, mine the top layers of soil (overburden) are removed to expose the seam of coal. The coal is then removed and the overburden placed back in the open pit.

4. Evaluation:

a) Student can determine and be aware of what types of mines are present in their area, if any!

b) Teacher evaluation.

5. Further activities:

a) Field trip

b) Films

c) Individual or group problem solving techniques

6. Resources:

a) Underground Mining Equipment Manual, 1978

E. Coal Terminology

BTU - British thermal unit. A measure of energy, it is the amount of heat needed to raise the temperature of one pound of water by one degree Fahrenheit. A BTU is a convenient measure by which to compare the energy content of various fuels.

Coal Analysis - determines the composition and properties of coal so it can be ranked and used most effectively. Four major rankings:

1. Proximate Analysis
2. Ultimate Analysis
3. Heating Value
4. Other tests

Proximate Analysis - determines on an "as-received basis" the moisture content, volatile matter (gases released when coal is heated), fixed carbon (solid fuel left after the volatile matter is driven off), and ash (impurities consisting of silica, iron, alumina, and other noncombustible matter). The moisture ckntent affects the ease with which coal can be handled and burned. The amount of volatile matter and fixed carbon provide quidelines for determining the intensity of the heat produced. Ash increases the weight of coal, adds to the cost of handling, and can affect the burning characteristics.

Ultimate Analysis - determines the amount of carbon, hydrogen, oxygen, nitrogen, and sulfur.

Heating Value - is determined in terms of BTU, both on an "as received basis" (including moisture) and on a dry basis.

Other Tests - include the determination of the ash-softening temperature, the free-swelling index (a guide to a coal's coking characteristics) and the Hardgrove grendability index (a measure of the ease with which coal can be pulverized). In a petrograhic analysis, thin sections of coal are studied with a microscope to determine the physical composition of coal, both for scientific purposes and for estimating a coal's coking potential.

UNIT II. Solar

A. Solar Transmission
B. Making A Small Classroom Solar Collector
C. Solar Convection
D. Solar Radiation
E. Mini-Solar Collector

A. Solar Transmission

1. At the end of this lesson, student will be able to determine the differences between solar convection, solar conduction and solar radiation as energy trasmissions.

2. Approx. time: One week.

3. Procedures
a)An introduction lesson on basic solar energy.
1. Experiment: student will take candle and light it. Closely observing flame, he will cup his hand a safe distance over flame until he feels the conduction of heat. Teacher will then explain this is a form of solar conductivity.
2. Experiment: student will take wire about one foot long and place in flame until he feels convection of heat. Teacher will then explain this is a form of solar convection.
3. Experiment: student will take hand and place along side of flame until he feels the radiation of heat. Teacher will then explain this is a form of solar radiation.

4. Evaluation:
a) students will be able to determine for themselves what type of energy transmission would be best suited for various purposes.
b) teacher evaluation.

5. Further activities:
a) Field trips
b) Films and slides
c) Individual or group problem solving techniques

6. Resources:
a) Energy Future, 1979, by Robert Stobaugh
b) Supplementary Energy Source by Amoco
c) Solar Projects by A. Joseph Garrison

B. Making a Small Classroom Solar Collector

1. Objective: students will design a small solar collector using common household materials.

2. Approx. time: One week (student projects)

3. Procedures: have a small group of students gather the following materials:

a) small box (cigar box size)
b) 3 ft. 1/8" plastic hoses
c) 2 sq. ft. of black visqueen
d) clear plastic wrap
e) quart jar with lid
f) tape, glue, punch, hand drill, 1/8" bit

Process:

a) glue visqueen inside box
b) drill holes 1" apart on side of box
c) loop hose through box, leaving long ends to jar
d) punch two 1/8" holes in top of water jar/place box towards sun and raise jar higher than box
e) siphon water through collector and place "hose ends" in jar, try to remove all air in hose

4. Evaluation: at the end of this experiment, student will be able to identify the following:

a) radiation - short wave radiation striking the collector is transferred into long wave (i.e., heat) energy
b) Convection - the difference in water temperature in the solar collector and jar causes the heat to move provided the collector is lower than the jar - this process is called thermal siphoning.
c) Conduction - the transfer of heat from one medium to another. The water is in close contact with the tube it is circulating through. As the water moves due to convection the water gains energy in the tube due to conduction.

Student will correctly label the following:

SUN

A. Radiation
B. Convection
C. Conduction

Collector Tubing

A. Radiation
B. Convection
C. Conduction

Jar

A. Radiation
B. Convection
C. Conduction

1. Energy transmitted from the sun, striking our body and making us feel warm is an example of _____.

2. A wire becoming hot when we hold it in a candle flame is an example of _____.

3. Temperature differences at the bottom and top of a room are due to _____.

5. Further Activities:
   a) Field trips
   b) Films and slides
   c) Individual and group problem solving techniques

6. Resources:
   a) Energy Future, 1979, by Robert Stobaugh
   b) Solar Projects, by A. Joseph Garrison

C. Solar Convection

1. Objective: After this lesson, students will understand why water convects better than air.

2. Approx. time: One period

3. Procedure: Place one egg in an oven set at 212 degrees. Place another egg in boiling water. After five minutes, remove both eggs, open and examine.

4. Evaluation:
   a) class discussion on results of experiment. Concept to be understood - liquids are much better than gases (air) at causing heat flow from an surface.
   b) teacher evaluation

5. Further Activities:
   a) Field trips
   b) Films and slides
   c) Individual or group problem solving techniques

6. Resources:
   a) How to Build a Solar Heater, by Ted Lucas
   b) Solar Projects, by A. Joseph Garrison

D. Solar Radiation

1. Objective: Student will understand that color is an important factor in solar radiation

2. Approx. time: class period

3. Procedure: Obtain one 3 X 5' piece of black cloth and one 3 X 5' piece of white cloth. On a sunny winter day, place the pieces of cloth on the snow. After one hour, have students examine and explain the results.

4. Evaluation:
   a) class discussion. Concept to be understood - the snow melted much more quickly under the black cloth because the black one absorbed more solar radiation. The white cloth reflected the sunlight.
   b) Teacher evaluation.

5. Further activities:
   a) Field trips
   b) Films and slides
   c) Individual or group problem solving techniques

6. Resources:
   a) How to Build a Solar Heater, by Ted Lucas
   b) Solar Projects, by A. Joseph Garrison

E. Mini-Solar Collector

1. Objective: Students will be able to demonstrate the abilities of different colored objects to absorb and retain solar energy.

2. Approx. time: One week (student project)

3. Procedures: Have a small group of students gather the following materials:
   a) six 8 oz. styrofoam cups with lids
   b) six small lab thermometers
   c) six different colored felt-tip markers
   d) timer (clock)
   e) graph paper

   1. students will color each cup except one which will be the "control" cup
   2. fill cups with water, cover and place thermometers through center of lid
   3. place cups in the sun
   4. record temperatures at various time intervals and plot data on the graph paper

4. Evaluation:
   a) student group will make a class presentation reporting data
   b) have class discussion using results
   c) how they can be used in a student designed solar collector
   d) teacher evaluation

5. Further activities:
   a) Field trips
   b) Films and slides
   c) Individual or group problem solving techniques

6. Resources:

a) How to Build a Solar Heater, by Ted Lucas
b) Energy and the Way We Live, by Melvin Franzberg
c) Solar Projects, by A. Joseph Garrison

UNIT III. Petroleum

A. Recovery of Oil
B. Items That Use Oil

A. Recovery of Oil

1. After this lesson, student will understand why less than one third of the oil in the ground is recovered by primary recovering methods, i.e., drilling and pumping.

2. Approx. time: one week

3. Procedure:
   a) teacher will introduce the process of the primary recover of oil
1. Experiment materials needed:
   A. one liter jar
   B. one can of motor oil
   C. one finger control sprayer (like Windex)
   D. #80 mesh screen
   E. one liter of course sand
   F. one gallon of hot water
2. Process for primary recovery:
   A. pour quart of oil in large empty jar
   B. place sand in jar until all oil is absorbed in sand
   C. cover suction end of sprayer with mesh screen
   D. push suction end of sprayer to bottom of jar
   E. have students pump as much oil as possible from simulated well
   F. have students measure amount of oil recovered
   G. have students calculate percentages of oil extracted compared to oil retained
3. Process for secondary recovery
   A. After all possible oil is extracted by primary recovery have students pour boiling water into simulated well
   B. Have students pump as much of the remaining oil and water solution into a graduated cylinder
   C. By having students exam collidal suspension have them determine the amount of oil recovered by this secondary recovery process

4. Evaluation:
   a) students should be aware of the primary and secondary recovery systems
   b) teacher evaluation

5. Further activities:
   a) Field trips
   b) Films and slides
   c) Individual or group problem solving techniques
   d) Discussion items

6. Resources:
   a) Arco's Elementary School of Oil Projects
   b) Energy by Melvin Kranzberg
   c) Oil In Depth by Amoco

B. Items That Use Oil

1. Objective: after this lesson, student will be able to identify items that contain oil

2. Approx. time:
   a) using common classroom items, student will discuss why petroleum is important in the development of these items:

   Examples:

   1. Books
   2. Carpet
   3. Sport Equipment
   4. Window glass
   5. Desks
   6. Plastic cups
   7. Paneling
   8. Fiberglass
   9. Vinyl
   10. Clothing

4. Evaluation:
   a) students should readily understand the importance of petroleum and its by products
   b) teacher evaluation

5. Further activities:
   a) Field trips
   b) Films and slides
   c) Individual or group problem solving techniques
   d) Discussion items

6. Resources:
   a) Oil in Depth by Amoco

UNIT IV. HEAT PUMPS

Title: Heat Pumps: An Energy Alternative-

Concept: As the fossil fuels of today become increasingly difficult to obtain, the electric powered heat pump offers an energy efficient option

Lesson I: Compression and Heat
Lesson II: The History and Principles of a Heat Pump
Lesson III: The History and Principles of a Heat Pump
Lesson IV: The History and Principles of a Heat Pump
Lesson V: Practical Application of Heat Pumps
Lesson VI: Practical Application of Heat Pumps
Lesson VII: Practical Application of Heat Pumps

Lesson I: Compression and Heat

Objective: To illustrate to the students the principle of heat obtained through compression of a gas

Approx. Teaching Time: One instructional period. 4-6 Jr. Sr. High

Procedures:
I. Diagram and lecture by teacher - to show progression of steps, what actually occurs
II. Audio visual aid - filmstrip and/or short film - to illustrate same
III. Demonstration - hands on experience
Basketball pump - feel heat being generated on needle
Fire syringe - low kindling point allows burning to occur
12 volt compressor - monitored for cylinder head temperature and temperature discharged

Evaluation: Same or next day quiz (oral or written)

Further Activities: Individual or group projects, reports, problem solving

Resources: materials available
Prentice-Hall supplies - fire syringe
Bullfrog Films: Bill Loosely's Heat Pump
Compressor can be obtained at automotive stores, hobby shops

Lesson II: The History and Principles of a Heat Pump

Grade Levels: 4-6

Objectives: students will:
1) describe the development of the heat pump
2) draw a diagram of the heat-energy flow principle
3) apply the heat-energy flow principle to the process of the heat pump

Time: 2-3 instructional periods

Procedures:

1) discuss the relationship of the refrigerator and the heat pump and how John Corrie and Lord Kelvin both used this same principle: compressed gas (air) causes temperature to rise
2) assign homework task: have students examine the freon systems used in their refrigerators
3) discuss the principle of heat-energy flow: heat energy will flow naturally from a warmer area to a cooler area
4) draw a diagram of the heat-energy flow - use chalk board or overhead projector
5) have students copy and label the heat-energy flow diagram
6) make a ditto of a diagram of an air-to-air heat pump
7) have students compare the diagrams of the heat-energy flow and the air-to-air heat pump
8) discuss how the heat-energy flow principle is used in the heat pump
9) discuss what happens when the heat pump cycle is reversed (refrigeration)

Evaluation: evaluation can be made by:

1) use of an oral test
2) use of a written test (including diagrams)
3) individual projects
4) teacher evaluation of materials

Further Activities:

1) have students do research papers on John Gorrie or Lord Kelvin
2) have students do reports on the refrigerator or the heat pump
3) have a heating specialist speak to the class
4) visit a facility that uses the air-to-air heat pump

Resources:

1) Heat Pumps, an Efficient Heating and Cooling Alternative, Dermot McGuigan, Garden Way Pub. Co., 1981
2) Center for Energy Policy and Research, New York Institute of Technology, Old Westbury, N.Y., 11588

Lesson III: History and Principles of the Heat Pump

Objectives: students of today need to become aware of the need to conserve and use more efficiently the electricity they all use. As future homemakers, they need to know the various ways to heat a home and to have a little understanding of the basic principles involved. This lesson is designed to provide this information and to show where and how a potential home builder or home owner may obtain facts and figures to use in making a decision about heat.

Approx. Teaching Time: 2-3 days for 4, 5, 6th grade
2-3 40 min. periods for 7-12th grade

Procedures:

1) group discussion
preceed this lesson with questions and surveys concerning home

heating costs, the types of fuel commonly used, and create interest by relating to household budgeting

2) motivation
post unlabeled drawing of a heat pump and initiate contest to name this "mystery" heat source. Winner will be awarded free time in accordance with class reward system. One week or less is enough time

3) class work
   a) after naming or identifying the heat pump, keep mood of a mystery - more or less depending on age group of students - and assign research from:
      heat pump companies
      community resources - i.e., area engineers, users if possible, home and/or companies
      teacher prepared data
   b) presentations
      hand out sheet of schematic of heat pump and label together. Keep theory discussion basic and simple. Discuss:
      1) any data received can be discussed and placed in an interest center
      2) if possible, make a field trip to a home or business which uses a heat pump. If not, investigate the possibility of obtaining a small unit to place in class and to demonstrate

Evaluation: teacher decision will be necessary in choice of written work, true/false, find the error or just a point system for research accomplished. Grade level, maturity of student to understand this concept and materials available will affect degree of evaluation practical. As a goal, the following facts should be covered:

   a) the heat pump and the refrigerator use the same principles, compression of a gas to cause its temperature to rise
   b) T.G.N. Haldane made the first heat pump in Scotland in 1926. It used electricity for power and extracted 2 to 3 times the energy his heat pump used. It was used for homes up through the 1950's and 1960's but compression problems resulted in limited sales
   c) the Oil Embargo of 1973 resulted in sudden investments to improve alternate methods to heat homes and corporations. This brought renewed interest in the heat pump and the fact that it makes more efficient use of the electricity it uses
   d) heat pumps multiply heat. The compressor raises the low temperature heat to a temperature that can be used for heating. Specifically, in the summer, the pump removes heat from the interior of a building or home and discharges it outside (air conditioning). In the winter, it does the opposite, extracting heat from the outside and pumping it into the building. It is more efficient than conventional electric heating because the heat pump can produce up to 3 times as much output in thermal energy as it receives in electrical input

Comments:

1) this concept uses basic principles, but comprehension by the students will be determined by their sophistication and experience. The teacher must determine the depth of study practical to inform his/her students about this heating option
2) the ingenuity of the teacher can motivate interest whether a mystery approach, science fair display, space age needs, format be used
3) the accompanying schematic can be used to make a transparency, dittos, a poster, a game board and can be color coded to assist in understanding its operation

Extended Activities:

make use of all and any community resources. Ideally, a small unit would be obtained and used for demonstration.

As other options are investigated, compare and display.

Resources:

1) CALMAC Manufacturing Co.
150 BRUNT ST.
Englewood, N.J. 07631
(makes water source heat pumps)

2) CARRIER Air Conditioning Co.
CARRIER Pkwy.
Syracuse, N.Y. 13201
(make 6 models of the weathermaker)

3) FEDDERS Corp.
Woodbridge Ave.
Edison, N.J. 08817
(makes water and air source)

4) GERVAIS Equipment
9295 Fargo Rd.
Stafford, N.Y. 14143
(water source heat pumps)

5) Poster - Energy Search
N.S.T.A. Publishing
1742 Conn. Ave. N.W.
Washington, D.C. 20009
($5 and $2 postage)

6) Book: Heat Pumps - An Efficient Heating and Cooling Alternative,
Dermot McGuigan, Garden Way Pub. Co.
Charlotte, Vt. 05445 ©1981

7) FACT SHEET: DOE/CS-0088 May 1979
HEAT PUMPS
U.S. Dept. of Energy,
Technical Infor. Center
P.O. Box 621
Oak Ridge, TN. 37830

Lesson IV. History and Principles of Heat Pumps

Objective: to inform the students of both the developmental history and the operational principles of the heat pump system

Time Line: Min. 8 hrs. Jr. High and High School (teacher discretion)

Procedures:

1) lecture by instructor incorporated with reading assignments, audio visual aides and use of guest lecturer with expertise in the area of heat pumps

2) have students draw and label the heat pump system which would include a flow diagram and a brief explanation of what occurs within the heat pump system. Each student could complete a written and/or oral report on the historical significance of the heat pump system

Evaluation: written or oral tests and teacher evaluation of students' performance and comprehension

Further Activities: individual reports on an indepth study of operational principles or on pioneer individuals in the field of heat pumps

Resources:

Energy Future
Published by Ballantine Books
Edited by Robert Stobaugh and Daniel Yergin

Heat Pumps
U.S. Department of Energy
P.O. Box 62
Oak Ridge, Tn. 37830

Bullfrog Films
Oley, Pennsylvania 19547

Lesson V. Practical Application of Heat Pumps

Objective: to provide the students with information on the uses of heat pumps and what it means to their environment

Time Line: Min. 8 hrs. Jr. High and HIgh School (teacher discretion)

Procedures:

1) text readings, lecture, read any and all state or federal heat pump project reports, audio visual aides and possible lecture by experts or researchers in the field
2) have students analyze the practicability of the installation of the heat pump system in their own home complete with a material and cost analysis. Students could also write a report on the efficiency of the heat pump system versus standard fossil fuel systems

Evaluation: Each teacher should gear suggested activities to the class level without a great deal of technical jargon. Written or oral tests and teacher evaluation of students' performance and comprehension can also be used to evaluate lessons.

Further Activities: Individual research and reports on experimental activities in the field above and beyond standard practices. Have students poll and report on a cross section of private owners in the area using heat pump systems

Resources: Energy Future
Published by Ballantine Books
Edited by Robert Stobaugh and Daniel Yergin

Heat Pumps
U.S. Department of Energy
P.O. Box 62
Oak Ridge, TN. 37830

Evaluation of Water Sources Heat Pumps for the Juneau, Alaska Area
Alaska Power Administration

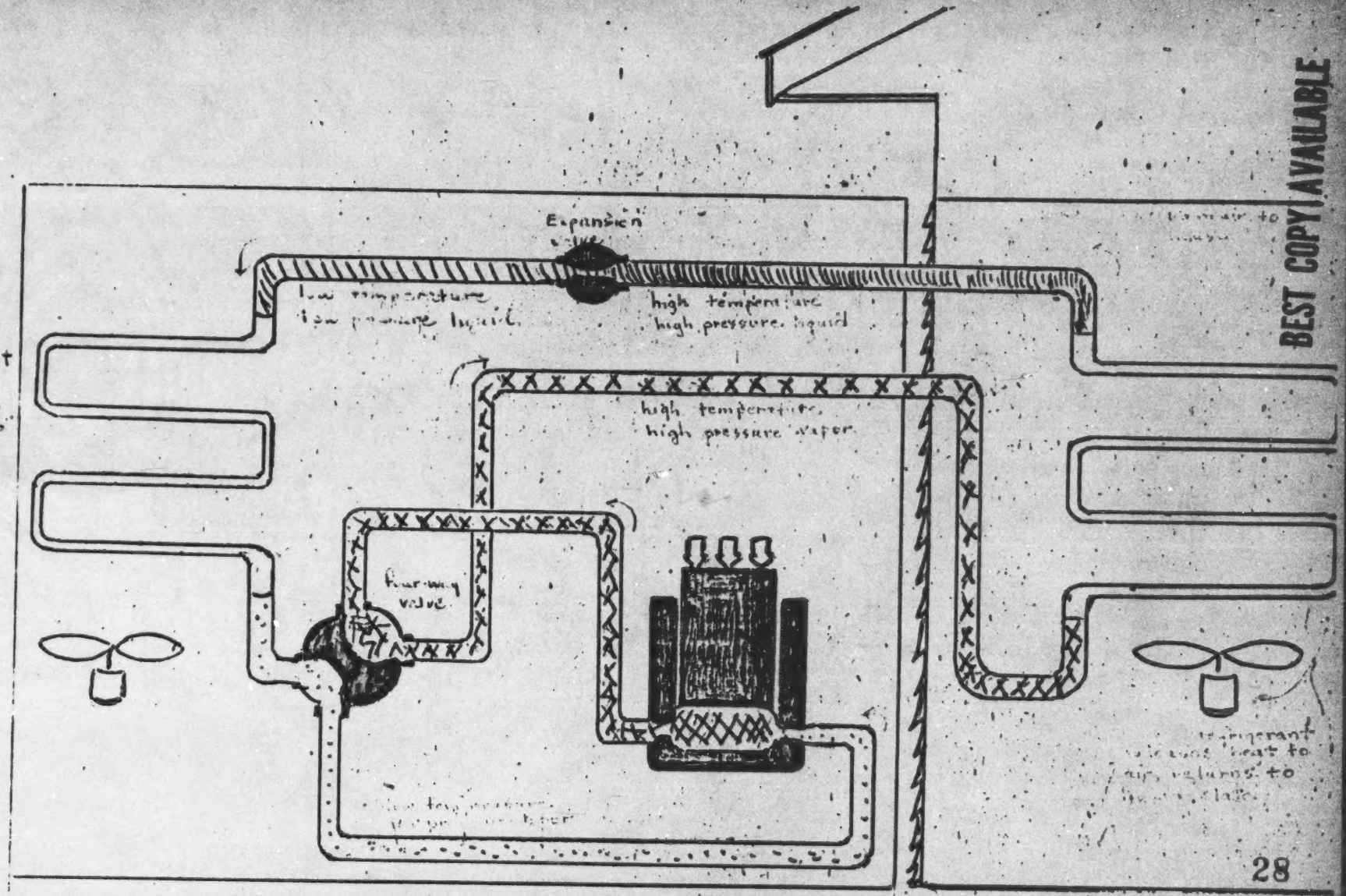
Lesson VI. Practical Applications of the Heat Pump

Objective: Information provided in this lesson will show how and where the heat pump is presently being used, the advantages and disadvantages it offers, and its future potential use.

Approx. Teaching Time: 2-3 days 4, 5, 6th grades
2-3 40 min. periods 7-12th grades

Procedures:

1) Group Discussion - this lesson should follow within one or two weeks of Lesson I. After the initial investigation of the history and basic principles of the heat pump, a discussion can be suggested concerning the practicality of using such a system. Students may be assigned to gather information. The teacher might pre-record a cassette or two for the listening center covering the following points of information:
   A) there are several heat sources used: air, water (well water, surface water, sea water), solar, earth energy
   B) the installer chooses the available and most economical source to use
   C) a survey might be made of local home owners and businesses to determine use of the heat pump and which kind. This should be recorded in graph/survey form
   D) advantages of this system include:
      1. --the heat pump is cheaper to operate when its cost effectiveness has been studied in advance and is most efficient when required to raise the least number of degrees of temperature
      2. --one heat pump provides both heat and cooling using only one system of distribution
      3. --a heat pump is clean and safe
      4. --a heat pump can be made to use any constant supply of low grade heat
   E. disadvantages of this system include:
      1. the initial cost can be 25% or higher than an oil or gas furnace
      2. some units are noisy. Care must be taken in selection and placement of a unit



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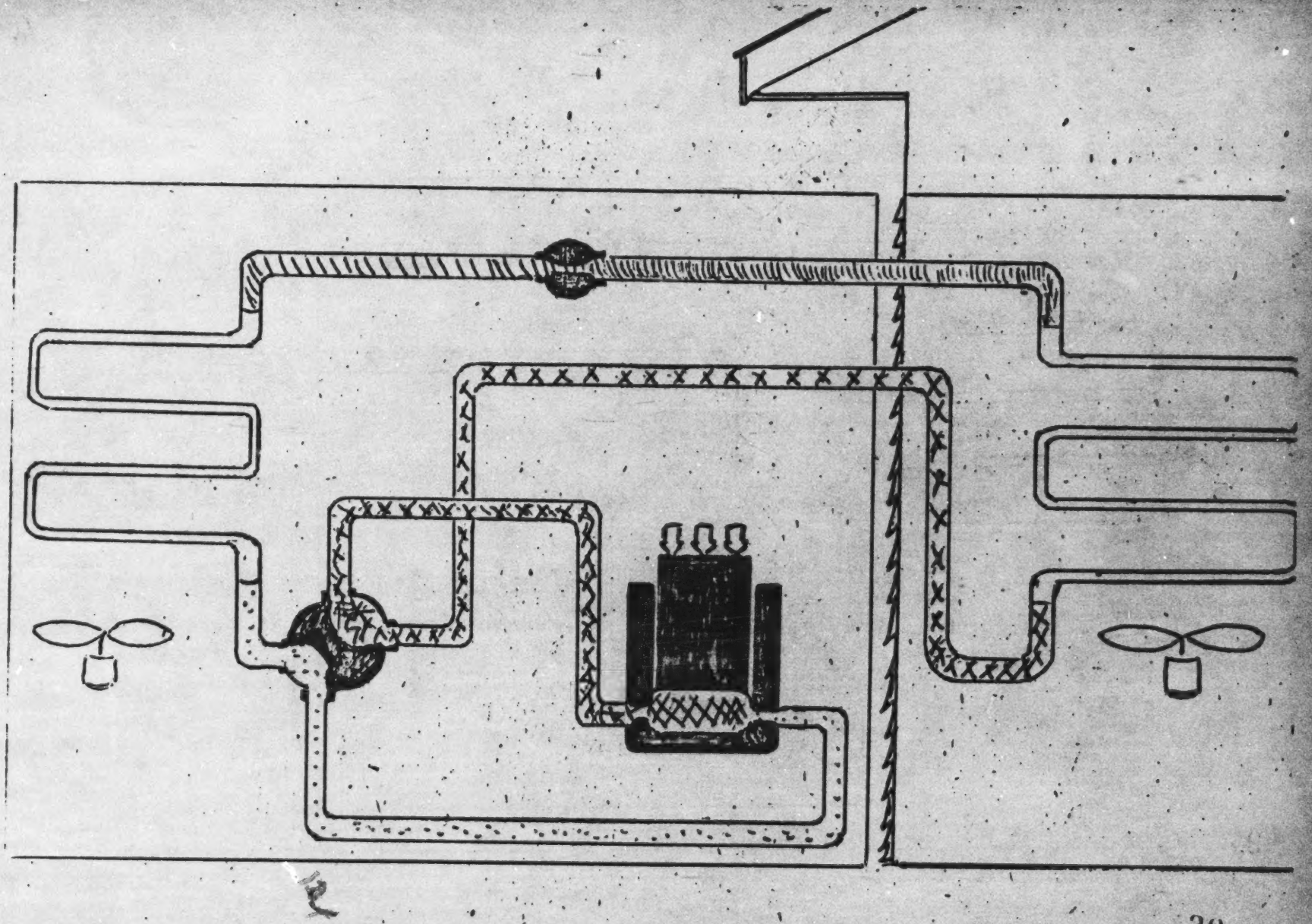

3. there is some question of the continuing ability of the unit to reverse its process from warm outside weather to cooler outside weather and accommodate its need. Extreme differences in climate decrease the pump's efficiency

F. continued future use of the heat pump seems contingent on:
1. the part of the country you live in (a warmer climate requires less "work" from the heat pump, where the difference in outside temperature varies within 20-30 degrees from summer to winter)
2. whether installation is to be in a new home or business or refitted (larger ducts are needed in this system)
3. the improvement in the compression mechanism which has provided some problems of noise and breakdown
4. a lowering of the installation costs of this system

2. information recording:
a poster may be added to the display center listing the facts obtained from listening to the tape(s) and the discussion. Individual notebooks or folders should also be added to. At this point, some opinions should be forthcoming. These also can be recorded

Evaluation:
teacher judgement must determine suitable assessment of understanding student has achieved. Care should be taken in level of difficulty selected

Comments: it will be very helpful to obtain pamphlets and booklets about heat and energy conservation, heat pumps, and comparative information from homeowners and businesses who/which use heat pumps. A local distributor, if there is one, could assist

Resources:

1. Federal Bldg.
Fairbanks, AK 99701
(presently using heat pumps for heat and air conditioning)

2. Juneau Experiment -
Dept. of Energy Report
DOE/CS-0088 May 1979
U.S. Dept. of Energy
Information Center
P.O. Box 62
Oak Ridge, TN. 37830

3. Book - Heat Pumps - An Efficient Heating and Cooling Alternative
Dermot McGuigan
Garden Way Pub. Co.
Charlotte, Vt. 05445 @ 1981

4. Public Library or nearest College Library

Lesson VII. Practical Applications of a Heat Pump

Levels: 4-6

Objectives: students will:
a) list the types of heat pump systems

b) decide which type of heat pump is best suited for use in different geographical areas of the United States
c) decide if the heat pump is a feasible energy alternative in their geographical location

Time: 2 instruction periods

Procedures:

1) discuss and make diagrams (on chalkboard, overhead projector dittos) of the three most available types of heat pumps - a) air-to-air, b) water-to-air, c) ground-to-air
2) discuss the locations in the United States where these heat pumps are used
3) discuss the climates of these locations
4) have students infer why a certain type of heat pump is better suited to each region
5) have the class debate and reach a concensus as to which type of heat pump would best be suited to use in their location

Further Activities:

1) visit facilities using the different types of heat pumps
2) make a map of the United States showing where the different types of heat pumps are being used

Resources:

Heat Pumps, An Efficient Heating and Cooling Alternative

Evaluation of Water Source Heat Pumps for the Juneau, Alaska Area, Pacific Northwest Laboratory, Richland, Washington 99352

UNIT V. Conserving Energy

Concepts: Energy can be conserved by being selective in choosing design and materials to build a new structure, by upgrading an existing structure, and by re-examining our daily use of energy resources.

Lesson I: Choices Available in Design and Materials for New Construction
Lesson II: New Construction Alternatives
Lesson III: Retro Fits and Upgrading of Existing Structures
Lesson IV: Consumer and Individual Use of Energy
Lesson V: Consumer and Individual Use of Energy

Lesson I: Choices Available in Design and Materials for New Construction

Objective: this lesson will show examples of new and old building designs and information about various types of materials, (their characteristics and strengths) currently being used in new construction to make best use of energy efficient goals.

Approx. Teaching Time: Grades 4, 5, 6 3 days
Grades 7-12 1-3 periods

Procedures:

1. make use of audio visual materials to show students:
   a) designs in solar heated homes, wind-generated-powered homes, earth enclosed structures, super-insulated buildings - A Building in the Sun, The Solar Frontier Log House, (Bullfrog Films)
   b) examples of buildings designed for specific climates and specific purposes - see enclosed sheet
   c) several stages in the construction of a building designed to conserve energy and to be energy efficient - Building the Solar Home - U.S. Dept. of Energy
2. initiate student research from:
   a) the school and/or local library
   b) local architects and engineers
   c) building supply stores
3. present teacher lecture using information obtained from adult brochures and books and incorporate discussion with student reports of their results and findings. Be sure the following points are covered:
   a) a wide variety of designs and materials are available for use by the potential builder for homes, businesses, schools
   b) information and advise are also available from state, federal and cooperative extension agencies
   c) the new builder must plan well to make the best efficient uses of the energy available in his area - he must consider the structure best suited for his climate, his budget, the purpose for the structure
   d) a great savings is possible by doing all these things

Evaluation: oral and written evaluation by students of information uncovered. For teacher, consider whether more A.V. might help illustrate this topic

Comments: if information is limited, a teacher prepared transparency coupled with a speaker might assist in presenting information

Extending Activities: community resources such as energy offices or the Chamber of Commerce might combine with student research to present an evening program for parents

Resources:

Bullfrog Films: A Building in the Sun - solar and architecture, Oley, PA 19547

The Solar Frontier - solar homes in the Canadian snowbelt

Log House - detailed view of a modern log house under construction

Books: Earth Sheltered Housing Designs - prepared by the Underground Space Center, University of Minnesota
Van Nostrand Reinhold Company NY 1978

Pamphlets: Local Extension Service

"Building The Solar Home" - U.S. Dept. of Energy, Report #2
June, 1978 HUD-PDR-296-1

"Math in Energy" - U.S. Dept. of Energy, Aug. 79, HUD/U3841-02

"Networks: How Energy Links People, Goods, and Services" - June 1979, DOE/CA/3841-1

Lesson II: New Construction Alternatives
a. Materials
b. Design/Building Techniques

Objective: To provide the students with information and an understanding of what is available and how it can improve their environment and the retardation of energy consumption in the world today.

Time Line: Min. 10 hrs.

Level: Jr. High and High School

Procedures:

Lectures, readings, field trips, audio visual aides and guest lectures by experts in the field.

In addition to the information gained by the above methods and input, students could conduct interviews and reports on new construction within their area and contrast it in report form (written or oral) with the alternative methods they are learning about. If the course is a

vocational class, have students construct a wall section using the new materials and building techniques.

Evaluation: Tests, oral discussions, teacher evaluation of reports, comprehension level of students and oral discussion.

Further Activities:

Have students conduct a cost analysis on materials available and what the cost differential over traditional materials used in construction would be.

Resources: The Energy-Efficient Construction Manual, A Handbook for Builders and Developers, North Dakota Energy Extension Service Program.

"Vapor Barriers for Log Houses," Building in Alaska (reports), Cooperative Extension Service, University of Alaska.

Designs of Roofs for Northern Residential Construction

Alternate Details for Northern Residential Construction

Bullfrog Films, Oley Penn.

1. How to Keep the Heat in Your House
2. Log House

Earth Sheltered Housing Design, The Underground Space Center, University of Minnesota.

MATERIAL	FORM	ADVANTAGES	DISADVANTAGES	R-VALUE PER INCH	U-VALUE	SPECIAL NOTE
Fiberglass	Loose fill blankets, bats	Inexpensive, fire resistant	Particles can irritate skin	3.3	.30	Gives off odor when damp
Polystyrene	Rigid Board	Useful for below-grade floors	Highly combustible	3.4	.29	Easily dented
Cellulose	Loose fill	Permits installation through small holes	Must be treated for fire resistance	3.7	.27	
Urethane	Foamed in place	Highly efficient	Can leak through loose wall boards or other openings	6.25 to 8.25	.16 to .12	Requires professional installation
Urea Formaldehyde	Foamed in place, rigid when dry	Excellent for exterior walls; fire resistant	Can leak through loose wall boards or other openings.	4.0 to 4.8	.25 to .21	Requires professional installation
Celotex - Thermax	Rigid Board	Best insulation efficiency	If used on outside of exterior wall, may not allow wall to dissipate moisture	7.2	.138	Both sides foil faced
Styrofoam	Rigid Board	Best insulation for underground and foundation		5.0	.20	Best insulation for underground or foundation
Vermiculite	Loose fill	Hollow core blocks, small spaces	Low efficiency	2.0	.5	Absorbs moisture
Perlite	Loose fill	Hollow core blocks, small spaces	Low efficiency	2.7	.37	Absorbs moisture

R Value — a materials ability to resist heat flow or heat loss.

$R = \frac{1}{U}$ example: Fiberglass R 3.3 = 1 ÷ .30 = 3.3

U Value — the amount of heat (BTU s) that passes through a square foot of material each hour for each degree of temperature difference between the inside and outside. The U Value is the reciprocal of the R Value.

$U = \frac{1}{R}$ example: Fiberglass U .30 = 1 ÷ 3.3 = .30

BTU — British Thermal Unit — the amount of heat required to raise one pound of water one degree of Fahrenheit temperature.

DEPD-82-055-B6

Recycle to a friend

DIVISION OF ENERGY & POWER DEVELOPMENT
ALASKA ENERGY EXTENSION SERVICE
9th FLOOR, MACKAY BUILDING, 338 DENALI STREET, ANCHORAGE, ALASKA 99501 - 3681, (907) 276-0508

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	Thickness (in.)	Trans-mittance	Weight/Area (lb/ft^2)	Thermal Expansion ($(^oF^{-1}x10)^{-5}$	Ease in Handling	Strength	Sheet Size (ft.)	Remarks
Water white glass "Solatex" (ASG)	0.125	0.90	1.60	0.47	Poor	Good (tempered)	2, 3, or 4 x 8	Very durable-no degradation
Float Glass	0.125	0.84	1.60	0.47	Poor	Good (tempered)	4 x 8	Very durable-no degradation
Window glass (ASG SS Lustro-glass)	0.090	0.91	1.20	0.47	Poor	Poor (non-tempered)	4 x 7	Fragile
Sunlite Premium II (Kalwall)	0.040	0.88	0.29	2.00	Excellent	Very good	4 or 5 width rolls	Maximum temp. 300°F
Filon w/ Tedlar (Vistron Corp.)	–	0.86	0.25	2.30	Very good	Very good	4.25 x 16	Maximum temp. 300°F
Flexiguard 7410 (3M)	7 mil	0.89	0.053	–	Fair	Good	4 x 180 roll	Maximum temp. 275°F
Tedlar (Dupont)	4 mil	0.96	0.028	2.80	Fair	Good, some embrittlement	up to 5.33 width roll (64 in.)	4-5 year lifetime at 150°F
Teflon FEP 100A (Dupont)	1 mil	0.96	0.02	5.85	Poor	Fair, not for exterior glazing	4.83 width roll (58 in.)	Maximum temp. 300°F
Swedcast 300 Acrylic (Swedlow Inc.)	0.125	0.93	0.77	4	Excellent	Very good	8 wide	Maximum Service temp. 200°F)
Lucite Acrylic (Dupont)	0.125	0.92	0.73	4	Very good	Very good	4 x 8	Maximum temp. 200°F
Tuffak-Twinwall (Rhom & Hass)	–	Equiv. to 0.39 for 1 layer	0.25	3.3	Very good	High impact strength fatigue cracking	4 x 8	5% reduction in transmittance over 5 years
Acrylite SDP (Cyro)	–	Equiv. to 0.53 for 1 layer	1.00	4	Very good	Good	6 x 8	Maximum Temp. 230°F
Sun-lite Insulated Panels (Kalwall)	–	Equiv. to 0.88 for 1 layer	0.7	–	Good	Good	4 x 8 4 x 10 4 x 12 4 x 14	Maximum temp. 300°F
Solar Glass Panels (ASG)	–	Equiv. to 0.90 for 1 layer	4.5	0.47	Poor	Good	3 or 4 x 8 3 or 4 x 8	Very durable
Regular Polyethylene (untreated plain)	1, 5, 2, 4, 8, 10 mil	90% Diffused	–	–	Very good	Must be stretched tight or inflated for strength	3' to 40' wide 50' or 100' rolls	Has a tendency to split on the fold. In shaded areas this material will last 2 years or more.
Vinyl Film	4.5 mil	90-95% Clear Diffused	–	–	Very good		4½' 8' Clear Only 7' to 40' wide	Diffused-light ones wider than 8' are fabricated by electronic sealing and may be ordered in widths from 7' to 40'

Recycle to a friend

DIVISION OF ENERGY & POWER DEVELOPMENT
ALASKA ENERGY EXTENSION SERVICE
8th FLOOR, MACKAY BUILDING, 338 DENALI STREET, ANCHORAGE, ALASKA 99501 - 3381, (907) 276-0508

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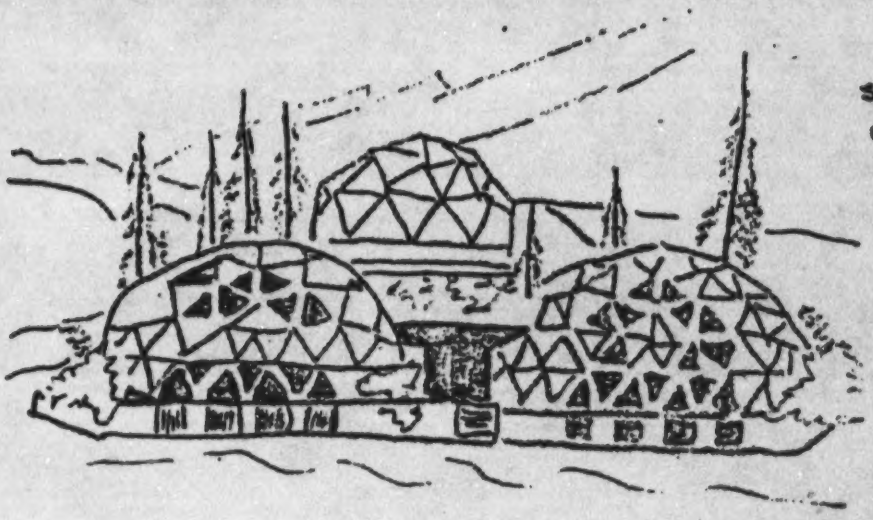
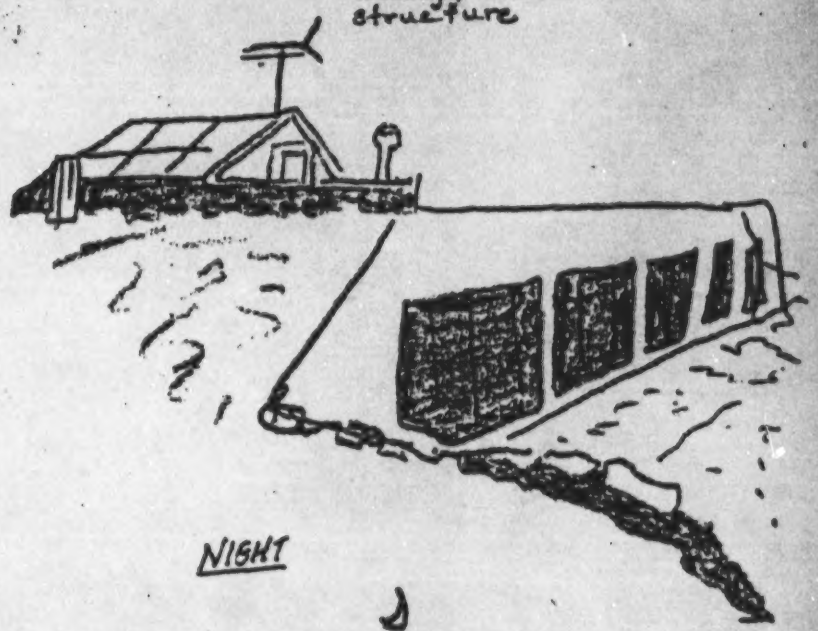
Geodesic Domes set in south facing slope sheltering rear of house with earth.



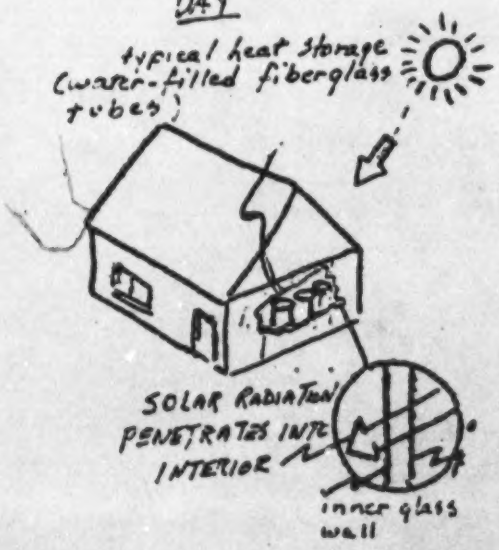
Ecology house - earth covered structure



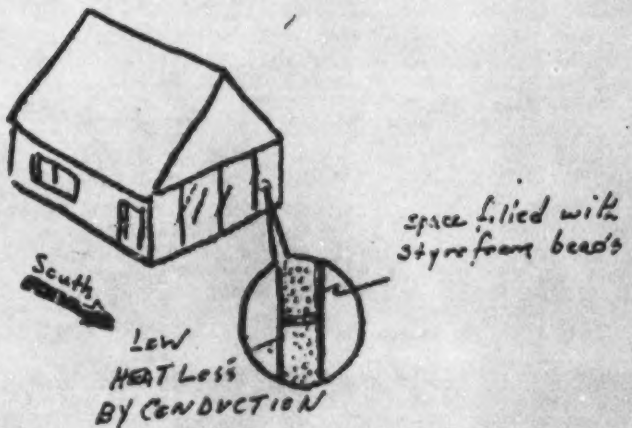
Foam Beads Prevent Nightime Heat Loss

DAY

typical heat storage (water-filled fiberglass tubes)



NIGHT



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Lesson III: Retrofits and Upgrading of Existing Structures

Objectives: Provide information about how present structures can be improved to maximize energy conservation.

Time: Two teaching periods. Level 4-6 grades.

Procedures:

1. Discuss R-values of materials in building construction - Tips on Insulating an Existing House, Axel R. Carlson.

2. A-V-Materials: Overhead Transparency film or film strip, if available. Bullfrog Films: Log House, Living the Good Life.

3. Student Research - library, extension service, local contractors and architects.

4. Student made diagrams and/or projects. Do lessons 1, 3b, 6: Science Activities in Energy-Conservation.

5. Student displays of materials.

Further Activities:

1. Interview resource people.

2. Evaluate their own individual home construction.

Evaluation:

1. Written and or oral tests.

2. Teacher evaluation of student materials.

References:

1. The Energy-Efficient Construction Manual: A Handbook for Builders and Developers, North Dakota Energy Extension SERvice Program, North Dakota State University, April, 1982.

2. Bullfrog Films '81-82 - How to Keep the Heat in Your House.

3. Building in Alaska: Tips on Insulating an Existing House: Axel R. Carlson - University of Alaska Cooperative Extension Service.

Lesson IV: Consumer and Individual Use of Energy

Objective: To show that we should investigate our daily use of energy and its relation to our environment and try to reduce waste. By doing this, it is possible to maintain our standard of living.

Approximate Teaching Time: Grades 4, 5, 6 2-3 days, grades 7-12 2-3 teaching periods.

Procedures:

I. Assign students activity cards of experiments that illustrate our daily waste of energy - Science Activities in Energy Conservation, U.S. Dept. of Energy.

II. Present films and/or filmstrips to further suggest our dependency on and inefficient use of our energy resources, and some wise choices/alternatives available - Bullfrog Films - "How to Keep Heat in your Homes," "The Home Conservation Series."

III. Arrange discussion groups with students reporting results of experiments and opinions of T.V. presented.

IV. Provide students with statistics which strengthen arguments for the need to conserve our energy - The Energy Wise Home Buyer - HUD Sept. 1979. Also see attached sheets.

Evaluation: Student reports, oral and/or written tests, creative thought about the problem and possible innovative solutions.

Comments: Adjust number and type of experiments to suitability for students, so that experiences meaningful to them in their environment will occur.

Extending Activities: Students might make study of energy sources and uses in their homes, and graph statistics involved. This information could be combined with Lessons I and II to form a workshop for other students and/or parents.

Resources: Pamphlets:

Energy, Resources and Environment - John Christensen, Kendall/Hunt Publ. Co., Dubuque, Iowa;
Conservation - Science Activities in Energy, U.S. Dept. of Energy, March 1980, Technical Information Center, P.O. Box 62, Oak Ridge, TN 37830;
The Energy Wise Home Buyer - Sept. 1979, HUD-PDR-412(2), Wash. D.C. 20410.

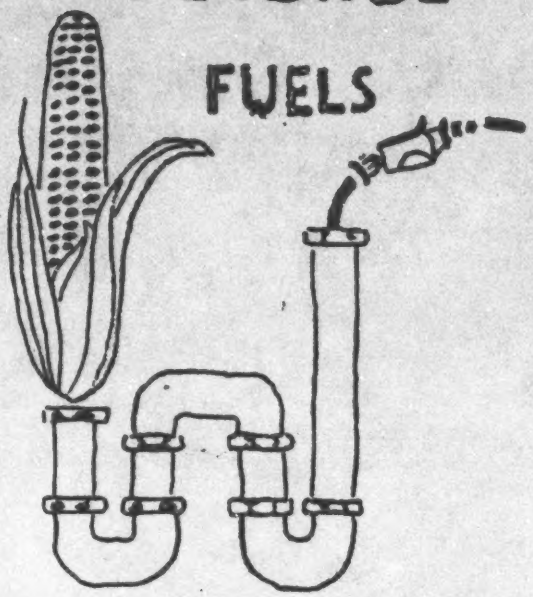
Bullfrog Films, Oley PA 19547
"The Home Conservation Series"
"How to Keep Heat in Your House"
"Living the Good Life," (grades 6 and up)
"Toast," (grades 3 and up)
"Go," (grades 1-4)
"New Western Energy Show" (grades 1 and up)
"Pedal Power," (grades 3 and up)

Extension Service pamphlets, speakers
Amoco Teaching Aides, P.O. Box 5910-A, Chicago, ILL., 60680, free booklets and pamphlets.

Lesson V: Consumer and Individual Use of Energy

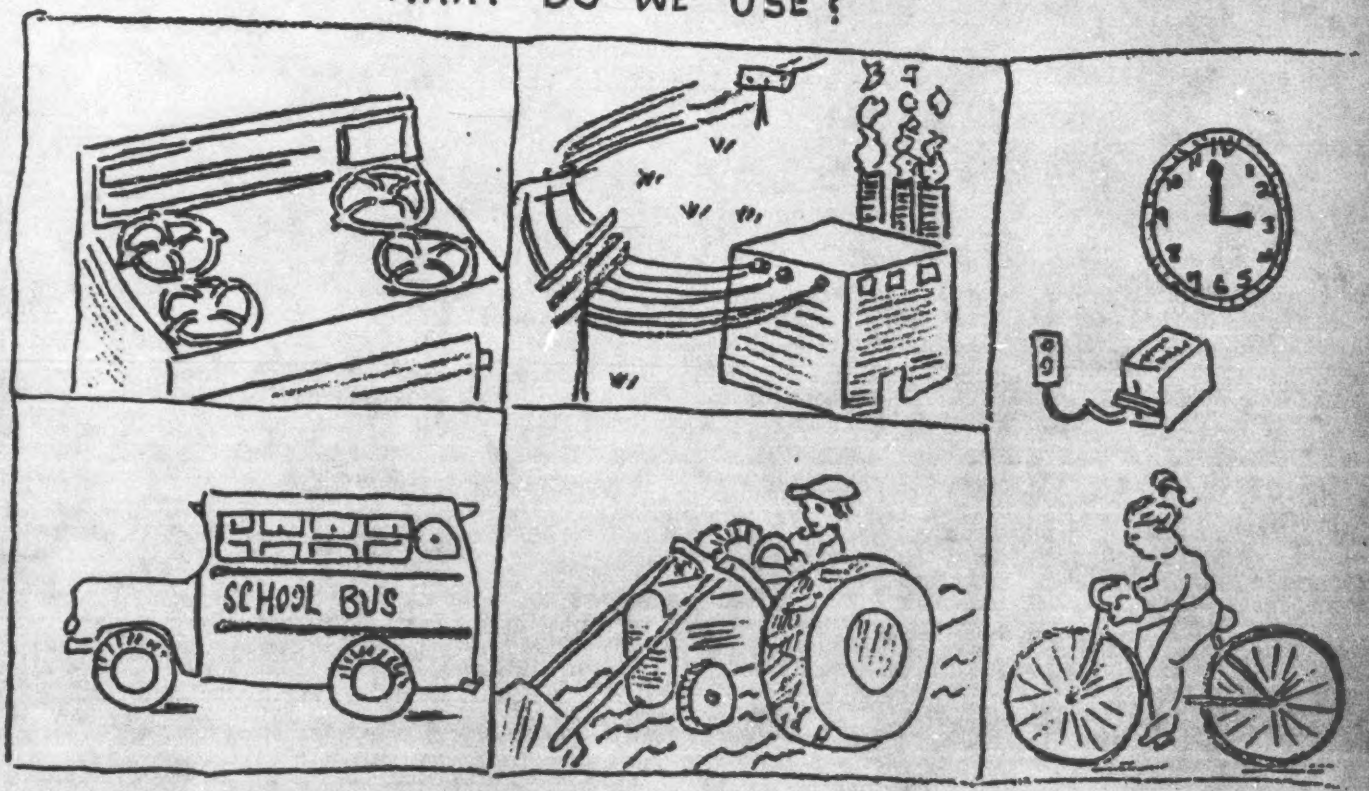
Objectives: Students will evaluate and practice energy conservation in their everyday lives.

ALCOHOL FUELS



CONSERVATION

WHAT DO WE USE?



Mileage Maker Tips

Save Energy

The most important single element in determining fuel economy of an automobile is the attitude, experience, and driving technique of the person behind the wheel. If you become a real pro and a safe driver you should get at least 30 per cent better mileage than a poor driver.

Slow down. It's one of the most important and practical things you can do to save gasoline. Wind resistance and power losses due to internal friction in the engine, and tire flexing, increase rapidly with car speed and require more energy and gasoline to move the car.

Here are some tips for conserving energy when operating your automobile:

Gasoline

- Use gasoline of proper octane rating. Using too low an octane rating may cause knock. Severe knock may result in engine damage. Premium lead-free gasoline is designed for cars that are in tune but knock when lower octane gasoline is used. It is also helpful where there is run-on after the ignition is turned off.

Tires and Brakes

- Check tire inflation pressure at least once a month, preferably when tires are cold. For best mileage and for driving on long trips with heavy loads, inflate tires to the manufacturer's recommended pressures. Underinflated tires can decrease fuel economy by as much as one mile per gallon.

  Consider using radial tires. They give better mileage per gallon and usually last longer.

- Make sure brakes are adjusted correctly. Dragging brakes reduce gasoline economy.

Driving Skills

- Smooth, steady acceleration can save as much as two miles per gallon, compared to fast, jerky starts.
- Drive at moderate speeds. Most cars get about 20 percent more miles per gallon at 55 than at 70.
- Keep speed constant when on the highway and driving conditions permit. Repeatedly varying speed by five miles per hour can reduce gas mileage over one mile per gallon.
- Avoid frequent lane changes on the highway. It's safer and saves gas, too. Bursts of acceleration may use fuel at ten times the normal rate.
- Don't idle the engine for excessive time periods, and don't race the engine when the car is not moving.
- Drive defensively. Use the brake as little as is consistent with safe driving. Pace your driving with the traffic flow and anticipate stops. Let the engine slow the car.
- Unnecessary use of air conditioning can cut fuel economy as much as two miles per gallon.
- Use your car wisely. Drive when you need to, not needlessly.

Maintenance

Peak energy-efficient performance in an automobile is obtained through proper maintenance. A good tune-up can improve mileage up to ten percent.

For safety and better operation, follow the specifications in your owner's manual.

- Install new spark plugs as specified. One misfiring spark plug can waste up to two gallons of gasoline per tankful.
- Inspect the distributor system, ignition wires and connections. Clean, tighten and replace as necessary.
- Set timing to specifications.
- Check ignition advance mechanism.
- Inspect the automatic choke for proper operation.
- Clean carburetor if necessary to remove gummy deposits.
- Check for fuel leaks at all connection points.
- Check exhaust gas recirculation system for proper operation.
- Clean or replace the PCV valve.
- Replace air and fuel filter elements.
- Check exhaust system for safety.

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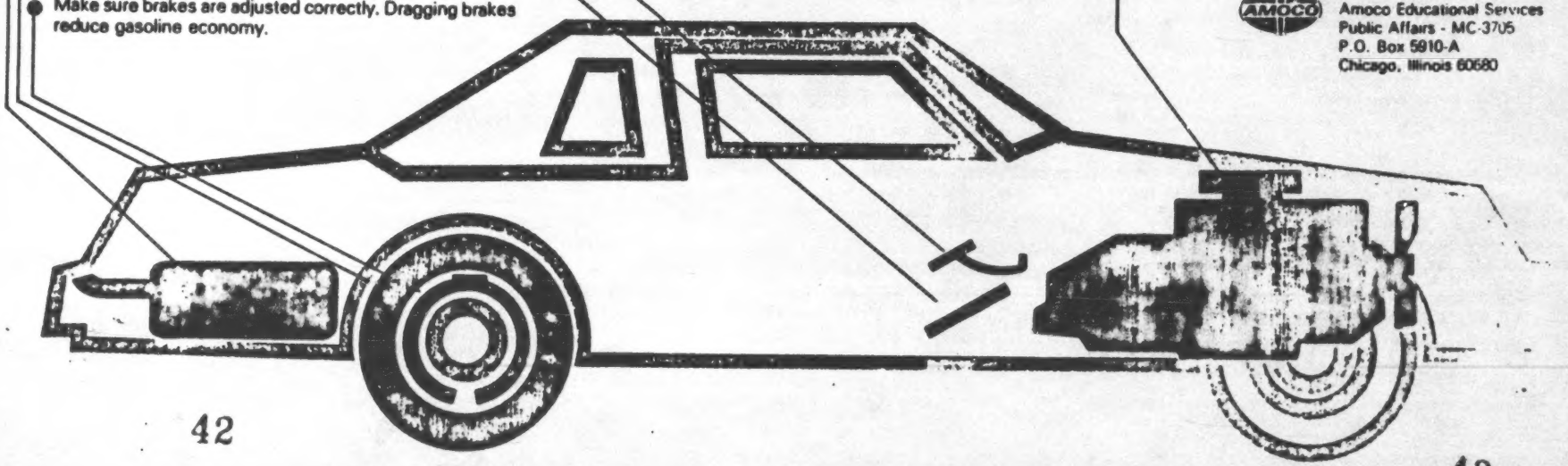

When the Heat's On

Getting the Best Performance Out of Your Furnace and Heating Unit is Essential for Keeping Your Home Warm and Comfortable. Trimming heating costs will save you money, too.

Insulation Saves $$$

One of the most important ways to conserve fuel in your home is to insulate walls, floors, and ceilings. Within a relatively short time, insulation costs will be more than paid for in fuel savings. Because over 50 percent of the heat in your house is lost through the walls and ceiling, and the most heat escapes from the ceilings through the roof, you'll save as much as 20 percent of your fuel bills by installing the proper maximum R-value insulation barrier in your attic floor or ceiling. The savings continue in the summer because the insulation also helps to retain the cool air inside the house and reduces the amount of heat the air conditioner must remove.

Stop the Draft

Some estimates indicate as much as 10 to 25 percent of your fuel dollar is lost through cracks. Weather stripping windows and doors and caulking all cracks that provide air leaks can prevent this loss. Most weather stripping is relatively inexpensive and easy to install by the homeowners.

Storm Windows Cut Losses

Tight fitting storm doors and windows can reduce your heating bills by almost 15 percent and prevent drafty rooms. Take advantage of the sun's heat. Let the sunlight warm your house during the day by keeping the drapes open. Then shut the drapes at night to retain the heat.

Proper Humidity Insures Comfort

Dry air robs your house of its moisture, and requires more heat to keep you comfortable. With proper humidification, most people can be comfortable at a much lower temperature than in an overly dry house. If the air inside your house is extremely dry, you can purchase a portable electric humidifier or add an automatic humidifier to the duct work of your heating system.

Thermostat Controls Savings

When your heating unit is not operating properly, check the thermostat first. It may be the source of your problem.

To check the thermostat's efficiency, place a thermometer in the middle of the room where the thermostat is located. If the temperature increases more than one or two degrees when the burner goes on, it may be a sign the thermostat readings are not accurate.

Once you find a setting that is comfortable to you, leave the thermostat at that mark. If your thermostat is properly located and in good condition, it will keep your house within one or two degrees of the desired temperature.

You can also conserve on fuel consumption by lowering your thermostat several degrees when not as much heat is needed. At night, you may want to reduce the temperature by four or five degrees. This reduction will give you a fuel savings of almost 5 percent if used for an eight-hour period every night.

Keeping Your Heating System Trouble-Free

Establish good maintenance to keep your heating system running efficiently. This will ensure the most comfort and economize on fuel consumption.

Watch for signs that indicate some problems in your heating system.

1. If fuel consumption rises substantially during a normal winter.
2. If the burner doesn't start up promptly.
3. Strange rattles or sounds in the burner, pump, or fan.
4. If your furnace turns on and off more often than usual. Check for a dirty filter.
5. A smoky chimney exhaust.
6. Excessive amounts of dirt or soot around air ducts, registers, and the furnace.

If you notice any of these changes or problems, try to locate the source of the trouble or contact your heating service contractor.

These routine checks will help to keep parts of your unit running smoothly. On a warm air system, make sure filters are clean.

Keep the space in front of vents clear of obstructing furniture and draperies. Shut off vents in rooms that are not being used.

You can also make some easy adjustments on hot water and steam heating systems.

Noisy radiators are often a result of air in the system. To get rid of the noise and the air, open the radiator vents until hot water begins to drain. Then close the vents.

If you have an oil heating system, your fuel tank may also be a trouble area if it is not properly maintained. If you keep your tank only partially filled for long periods of time, the upper portion of the tank may rust so keep the tank filled during the summer months.

Keeping your heating equipment in good order is extremely important for your continued heating comfort. An annual burner inspection and adjustment is also recommended for efficient operation.

Getting the Heat Back On

When your heating unit stops working completely, there are several simple checks that you should make before calling your fuel supplier. The problem sometimes can be easily fixed without professional help.

If you heat with oil:

1. First, set your thermostat at least five degrees higher than the current room temperatures.
2. Check for blown or loose fuses or a tripped circuit breaker in the main fuse box and burner switch box. Make sure that all switches, including circuit breakers affecting the oil burner, are "On." If you replace a blown-out fuse and the replacement also blows out or the circuit breaker retrips, you should call a serviceman.
3. With the thermostat set above room temperature, press the reset button. Reset buttons are usually colored red and located on the burner control box on the chimney smoke pipe, and on the burner or burner motor.

   CAUTION: If the burner runs for only a minute or two and shuts off, DO NOT PRESS THE RESET BUTTON AGAIN.
4. Be sure there is oil in the tank and the oil line valve is open.
5. The first and most important place to check on a steam or hot water system is the water level gauge. If the reading is low, open the water feed valve to regain a proper water level.

Time: 2-3 class periods, levels 4-6.

Procedures:

1. Discuss amounts of electrical use in homes and types of appliances used: Energy, Food and You - pg. 65.

2. A-V Materials: a) overhead transparencies of charts showing KWH of different appliances, b) films: Toast, Decision: Energy for the Future, Go, New Western Energy Show, Pedal Power - Bullfrog Films.

3. Student surveys of electrical use in their homes.

4. Student suggestions for energy conservation.

5. Individual student experiments from Science Activities in Energy: Conservation #'s 2, 4, 5, 7, 8, 13, 14.

6. Student demonstrations of energy saving appliances.

Further Activities:

1. Interview resource people.

2. Develop bulletin boards dealing with everyday practical aspects of energy conservation.

3. Student reports on how to conserve energy.

Evaluation:

1. Teacher evaluation of student materials.

2. Oral or written tests.

Resources:

1. Bullfrog Films: Oley Pennsylvania

2. Science Activities in Energy: Conservation: American Museum of Science & Energy

3. Energy Savers (pamphlet), Educational Services, Public & Government Affairs, P.O. Box 5910-A, Chicago, Ill.

4. Energy, Food and You. An interdisciplinary curriculum guide for elementary schools, Washington State Office of Health Education.

UNIT VI: Agriculture and Energy

Title: Energy Alternatives in Agriculture

Concept: Food production involves much more in the way of energy input than the energy from the sun. The mass production system that dominates agriculture can be thought of as one which converts various sources of energy into food energy.

Lesson I: Fuel From Farms - Agricultural Sites

Lesson II: Solar and Agriculture

Lesson III: Productivity and Energy Alternatives in Agriculture

Lesson I: Fuel from Agricultural Sites

Objectives: Investigate, explore and inform the students of the potential energy sources and methods that are available and being used, on extracting and generating fuel from animal and biomass wastes.

Time Line: 3 hours min.

Level: grades 3-12 depending on instructor presentation.

Procedures: Film, readings and field trip if possible. Students can conduct experiments using the biomass activity folder, then follow-up with group or individual reports to be discussed as a class.

Evaluation: Results of reports, oral or written exam and teacher evaluation.

Further Activities: Individual or group reports on agriculture projects within the community. Students could also conduct projects in agriculture in their home environment.

Resources:

Fuel from Farms
A Guide to Small Scale Ethanol Production
Solar Energy Institute

Bull Frog Films, Oley, Penn.
The Biogas Option
Fuel from Waste
Biogas in Fiji

Alaska's Rural Development
by Peter G. Cornwall & Gerald McBeath

Agriculture, Energy and Society
U.S. Department of Energy

Bio-Mass I
U.S. Department of Energy

Lesson II: Solar Energy and Agriculture

Objectives: To expose students to the experimenting farmers are using with solar energy to produce heat and energy (to generate electricity).

Approx. Teaching Time: 2-3 class periods, 3-6, 7-12.

Procedures:

1. Activities - assign small groups to follow instructions in Activity #4 (The Energy We Use Grade I, U.S. Dept. Energy folder), Science Activities in Energy, selections by teacher, Activity 9 (Agriculture, Energy and Society). Elect. activities and to prepare brief reports.

2. Audio visual presentations: films - Bull Frog films - The Solar Greenhouse, Solar Activities, Sun Dried Foods. Any materials available from local extension service (pamphlets, slides, photos).

3. Teacher and student reports: resources for the teacher will include readings in materials enclosed and those available. The following points should be covered:

   a. food has been produced by the direct transfer of energy from the sun up through the 19th century

   b. as farm machinery developed the use of fossil fuels was introduced

   c. today the increasing cost and decreasing supply of fossil fuels have resulted in renewed use of solar energy

   d. solar heat is being used by farmers to grow food, to dry grains

   e. solar energy is being used to generate electricity which in turn can heat farm buildings, operate drying bins, run farm machinery

   f. while initial costs of using solar energy may in some instances be prohibitive, they don't have to be. Small scale units may be instituted with the long range goal for our society being a reduction in food costs due to efficient use of this energy alternative - the SUN

Evaluation: student reports, written and/or oral tests

Extended Activities:

1. a field trip, if possible, to a farm which utilizes solar energy

2. a speaker from the extension service

3. start a card file for students to make each card containing an original idea of further ways to use the suns energy, possibly entitle it The Farm of the Future.

Resources:

A.V. Bullfrog Films

Books

The Solar Greenhouse - Bill Yanda, Rick Fisher, Muir Publications, Santa Fe, N. Mexico

Solar Projects - A. Jes Garrison, Running Press, Philadelphia, Pa.

Sun Up, Sun Down - Understanding Solar Energy, Shawn Buckley, McGraw Hill, N.Y.

Pamphlets:

U.S. Dept. of Energy

The Energy We Use

Passive Solar Heating - Division Energy & Power Div., Anchorage

Grade Level Booklets:

Energy and You, p. 112

Agriculture and Society, Lesson 9

Lesson III

Title: Productivity of Energy Alternatives in Agriculture

Objectives: To examine the methods and efficiency of energy alternatives used in producing agricultural products.

Grade Levels: 3-12

Time: 2-3 lesson periods

Procedures:

1. Show Bullfrog Films: a) Diet for a Small Planet, b) A Visit with J. I. Rodale, c) Potatoes, d) Waterloo Farmers, e) A Sense of Humans, f) Looking for Organic America, g) Garden Song, h) Getting the Most from Your Garden.

2. Do lessons 3-10 in Agriculture, Energy, and Society.

3. Do experiments 3, 4, 5, 7, 8, 10, 11 - Science Activities in Energy: Biomass I.

4. Do activities from section two: Energy and the U.S. Food System (pgs. 107-197), Energy, Food and You.

Evaluation:

1. Oral and/or written tests.

2. Teacher evaluation of: a) experiments, b) reports, c) projects

Further Activities:

1. Have students do reports on energy alternatives being used on farms today.

   Suggested topics for these reports:

   a) modern crop drying methods
   b) organic farming
   c) high-yield crops
   d) farming history

2. Field trips to local farms

3. Lectures and/or interviews with experts in this field

4. Student suggestions and demonstrations for energy alternatives in agriculture

References:

1. Bullfrog Films: Oley, PA 19547

2. Agriculture, Energy and Society: Interdisciplinary Student/Teacher Materials in Energy and the Economy, U.S. Dept. of Energy

3. Science Activities in Energy: Biomass I

4. Energy, Food and You: An interdisciplinary curriculum guide for elementary schools, Washington State Office of Health Education

5. Energy, Food and You: An interdisciplinary curriculum guide for secondary schools, Washington State Office of Health Education

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UNIT VII: WIND POWER

Concepts:

I. Historical Background

II. Causes of Wind

III. Measurement of Winds

IV. Wind Dependability

V. Wind as a Power Source

Lesson I.

What: Historical background of wind power

Why: Student will understand the historical uses of wind power

How: I. Student shall prepare a short paper on one of the following by using the encyclopedia or other sources:

1. Sailing vessels
2. Carousel windmills
3. European windmills
4. American fanwheel
5. Turbines

Time: 1 hour

Evaluation: Students shall, in a small group discussion, demonstrate an understanding of the historical uses of wind power.

Suggested questions:

1. Why was wind such an appropriate technology?
2. Why did we stop using wind power?
3. How and why would you apply wind power today?

Other Activities:

1. Activity #4, Wind Energy, DOE/IR-0037. An excellent activity with sail power.
2. Activity #5, Wind Energy, DOE/IR-0037.
3. Activity #6, Wind Energy, DOE/IR-0037. Shape of a boat.

4. Have a sail boat race with student designed boats.

5. Read Alaska Wind Energy Handbook, DOTPE, pp. 2-7.

Lesson II.

Title: Causes of Wind

Why: Prove heat causes wind

How:

1. Show film - Harness Wind*

2. Group discussion on association between heat and wind.

3. Reading from Alaskan Wind Energy Handbook, suggestions selection p. 14.

4. Do demonstration - candle heats pinwheel.

5. Oral discussion - unequal heating of earth's surface causes winds.

Time: One hour.

Evaluation: Ask these questions:

1. Does increased heat mean increased wind?

2. Is this true - no heat difference, no wind.

Other Activities:

1. Use candles of various sizes and pinwheels to determine which causes faster movement.

2. Do activity #8 from Science Activities in Energy Wind Power, DOE. This is an excellent activity on propeller construction.

3. Do activity #9 from Science Activities in Energy Wind Power, DOE. This activity deals with propeller size.

Lesson III.

Title: Measurement of Wind

Why: Show or teach that wind speed and direction can be measured.

Time: One hour

How (Activities):

1. Duplicate Beaufort Scale and distribute Wind Energy Science Activities, DOE.

2. Oral discussion on the scale.

3. Note and chart wind speed at a given time - all over school yard.

4. Ping Pong Ball wind speed test - do as class activity.

5. Read 57-63 Alaska Wind Energy Handbook.

Evaluation: Ask these questions:

1. Using Beaufort Scale, which extremes are experienced in your town?

2. What is the speediest time of the day? AM Noon PM?

Other Activities: Read Aviation Week and Space Tech, 3/1/67, pp. 50/51, "Wind Vortex."

Read Popular Sciences, Mar. 67, pp. 73-75, "World's Biggest Windmill."

Lesson IV.

Title: Wind Dependability

Why: Prove that wind is a dependable force.

Time: One hour

How: Activities:

1. Write to weather bureau for charts - committee project

2. Chart prevailing winds as class activities

3. Read Alaska Wind Handbook, pp. 18-21-22, 28

4. Oral discussion - who lives in windiest neighborhood

Evaluation: Written quiz - questions:

1. Do you think we could generate electricity here?

2. Why does one part of the community get more wind than another part?

Other Activities: Read Popular Science, Oct., 75, pp.50-51, Wind Power

Make Bulletin Board to show different symbols used in weather chart

Math: graphing wind data

Make an anemometer. See Alaska Wind Handbook, DOTPF

UNIT VIII. Hydropower

Concepts:

I. Water As An Energy Source

II. Determining the Hydro Potential of a Site

III. Hydro Equipment That Can be Made by Yourself

IV. Economics of Home Hydro

V. Cautions and Suggestions for Do It The Selfer

Lesson I.

What: Water As a Source of Energy

Time: 2 hours (easily split between 2 or more days), elementary level

How:

1. Look at (or have children bring in) a picture of a mill with a water wheel. A good source - Windmills and Watermills, Reynolds.

   -ask "What makes the wheel turn?" (moving water)

   - explain how farmers used to bring their corn and grain to the miller to grind on his mill

   - mill always located by the river to use the moving water to turn grinding wheels

2. Make a water wheel and see how it works. Excellent source - The Energy We Use, DOE 1970, HCP/U 3841-08.

3. Look at (or have children find) a picture of a hydroelectric power plant and dam.

   -ask "What is moving in the picture?" (water)

   - "Where is the water going?" (over the edge of the embankment)

   - "Who has seen a waterfall?"

   - "Please describe how it looked and the noise it made."

   -explain A dam is a man-made waterfall. It is built to use water as a source of energy.

   -tell The large building next to the dam is the power plant.

Other: Field trip to a hydroelectric installation or old mill if available.

Evaluation: Have students draw an old mill or hydroelectric dam and power plant.

Resources:

Windmills and Watermills by John Reynolds (Praeger, N.Y., 1970).

The Energy We Use, Grade 1 (U.S. Department of Energy, October, 1977).

Lesson II.

What: Determining Hydro Potential of a Site

Why: Establish if an area has hydro-power potential.

Time: One hour.

How:

1. Read 9-15 in Hydro Power, DOE/ET/01752-1, Microhydropower.

2. Demonstrate how to determine flow rate of a stream with float method (see description in Microhydropower).

3. See page 17, figure C - discuss other ways to do such.

4. Power calculation. Rate X Head/529 = Horsepower. Rate X Head/709 = KW.

Evaluation: Assign questions to committees:

1. Which has more power, a deep, narrow stream or a shallow wide stream.

2. For a given stream, how could we increase its power?

Other Activities:

Water Power, Bullfrog Films

Lesson III.

What: Hydro Equipment You Can Make

Why: Show how hydraulic ram functions.

Time: 2 hours.

How:

1. Duplicate and distribute fact sheet, Hydraulic Ram, DOE & P. Development, 82-055-132.

2. Oral lecture on formula for determining Q.

3. Take local stream and determine these facts (1) depth, (2) flow rate.

4. Compute for Q, (a) gallons per minute (supply of water), (b) vertical evaluation.

Evaluation: Give facts in written form and have class independently compute water flow.

Other Activities: Committees - write short essay on where this unit could be used and/or will this system be destroyed by break-up?

Lesson IV.

What: Economics of Home Hydro

Why: Do cost analysis to determine true cost.

Time: One hour.

How:

1. Have students write or call local electric company for rates (KW) and figure monthly electric bill.

2. Read, independently, pages 41-44 Micro-Hydro Power.

3. Use this analysis with local dollar amounts and prepare cost sheet.

Evaluation: Each student will make a graph similar to sample on page 43, Micro-Hydro Power.

Other Activities: Committees do research on sources for financial assistance. DOE; Small Hydro, Small Grants, State Grants and Tax Credits, Conventional Bank Loans.

UNIT IX. Tree Power

Concepts:

I. Wood Is a Fuel

II. Stoves vs. Fireplaces

III. Installation of Wood Burners

IV. Conversion to Wood

Lesson I.

What: Distillation of Wood

Why: Burn wood in the absence of air and collect the components, i.e., solids, liquids, and gases.

Time: 3 hours (this is best split over 2 or 3 days).

How: Set up the following equipment reference: Introductory Physical Science, Prentice-Hall.

1. Have students set up the equipment as illustrated above.

2. Discuss safety in the lab, goggles must be worn and alcohol burners carefully attended. Discuss flammability tests.

3. When everything is ready, have students light alcohol burners.

4. Trap gas initially driven off as the wood filled tub is heated (but before wood burns) - check flammability with a glowing wooden splint and a flaming splint.

5. Burn the wood until no more gas is produced (no more bubbles).

6. Examine the products of burning. Charcoal - glows when heated. Liquids - mostly water, some alcohol (may burn), tar, creosote, etc. (This is a problem area for wood stoves.) Gas - methane (and others) burns readily.

7. Discuss concept of "Conservation of Mass."

Evaluation: Have students write on the following question: "What happens to the products of combustion in a wood stove? Be sure to speak to solids, liquids and gases."

Resources: Introductory Physical Science, Prentice Hall.

Burning Wood, NRAES Cooperative Extension.

Lesson II.

What: Stoves vs. Fireplaces

Why: Demonstrate the efficiency of both woodstoves and fireplaces.

Time: One hour.

How:

1. Introduce lesson with this film: Wood Heat, by Home Energy Conservation Series, Bullfrog Films.

2. Divide class in to 2 debate groups: assign this:

group A - fireplaces
- a. old, conventional types
- b. free standing
- c. modified

group B - stoves
- a. air tight
- b. radiant heaters
- c. double chamber

Use reference "Burning Wood" NRAES Cooperative Education.

3. Have debate on efficiency of each type.

Evaluation: Written answer to question: (answer in paragraph form) How can you make a fireplace more efficient?

Other Activities:

1. Make bulletin board showing different kinds of stoves.

2. Call local vendors and secure prices of various heat units.

3. Do survey of homes to determine popularity of fireplaces and stoves.

Lesson III.

What: Installation of Wood Burners

Why: Teach the safest and most efficient methods of installation.

Time: One hour.

How:

1. Reproduce safety check list from page 22 Burning Wood, Cooperative Extension, NRAES.

2. Orally discuss each item - item by item.

3. Discuss what items are not practical for our areas.

4. Discuss topics or areas omitted, for examples (additions to remove creosote).

Evaluation: Orally ask these questions:

1. Why do more houses burn in the winter than summer?

2. What type of heating units cause most fires?

Other Activities:

1. Have a representative of the fire department visit the class to discuss safety in wood stove installation.

2. Discuss advantages of spreading wood ashes on garden and caution use of warm ashes.

3. Make soap.

Lesson V.

What: Conversion to Wood

Why: To determine economic practicability of burning wood.

Time: One hour.

How:

1. Do home survey to determine if wood stove is to be primary or secondary heat source.

2. By group discussion, discuss type of stove and best location for that stove.

3. List costs of installation - both secondary, primary.

4. Oral discussion of availability of wood fuel in local area.

5. Discuss problems/uses of waste products.

6. Cost of and desirabilty of back-up system.

Other Resources: Wood Heat, Bullfrog Films.

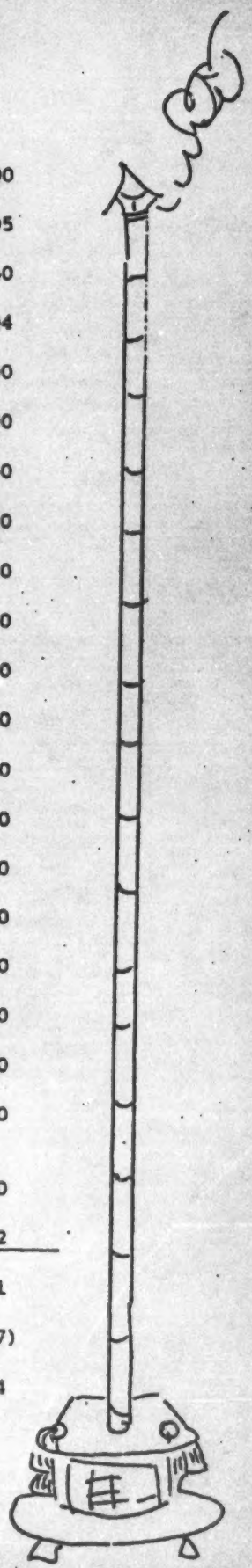
Other Activities:

1. Wood lot management - thinning, reseeding.

2. Measuring size of tree - tape (diameter scale), abney level, clinometer.

HOW YOU CAN SAVE MONEY WITH A WOODSTOVE:

STOVE, PIPE, INSTALLATION, ETC.	458.00
CHAIN SAW	149.95
GAS, MAINTENANCE FOR CHAIN SAW	44.60
4-WHEEL DRIVE PICKUP, STRIPPED	8,379.04
4-WHEEL DRIVE PICKUP, MAINTENANCE	438.00
REPLACE REAR WINDOW OF PICKUP (TWICE)	310.00
FINE FOR CUTTING UNMARKED TREE IN STATE FOREST	500.00
FOURTEEN CASES OF MICHELOB	125.00
LITTERING FINE	50.00
TOW CHARGE FROM CREEK	50.00
DOCTOR'S FEE FOR REMOVING SPLINTER FROM EYE	45.00
SAFETY GLASSES	29.50
EMERGENCY ROOM TREATMENT (BROKEN TOES, LOG DROPPED	125.00
SAFTEY SHOES	49.50
NEW LIVING ROOM CARPET	800.00
PAINT WALLS AND CEILING	110.00
WORCESTER CHIMNEY BRUSH AND RODS	45.00
LOG SPLITTER	150.00
FIFTEEN ACRE WOOD LOT	9,000.00
TAXES ON WOOD LOT	310.00
REPLACE COFFEE TABLE (CHOPPED AND BURNED WHILE DRUNK)	75.00
DIVORCE SETTLEMENT	33,678.22
TOTAL FIRST YEAR'S COSTS	54,922.81
SAVINGS IN "Conventiional" FUEL FIRST YEAR	(62.37)
NET COST OF FIRST YEAR'S WOODBURNING	54,860.44



Contributed by Jon E. Elam

ENERGY ACTIVITY: How much energy do we use? Sally Wells

Objective: To dramatically demonstrate the use of energy in our country in comparison to other countries in the world.

Nepalese	1/3 of a cookie crumb	0.3	mil BTU/yr.
Nigerian	1/3 of a cookie crumb	1.5	mil BTU/yr.
Indian	1 cookie	5	mil BTU/yr.
Chinese	2 1/2 cookies	13	mil BTU/yr
Lybian	2 1/2 cookies		
Egyptian	3 cookies	15	mil BTU/yr.
Saudia Arabian	3 1/2 cookies	18	
Somalian	3 1/2 cookies	18	
Syrian	3 1/2 cookies		
Angolian	4 cookies		
Rhodesian	5 cookies		
South African	6 cookies		
WORLD AVERAGE	7 cookies	35	mil BTU/yr.
Chilean	8 cookies	40	
Puerto Rican	16 cookies	100	
Russian	20 cookies	130	mil BTU/yr.
German	22 cookies	150	
AMERICAN	44 cookies	300	mil BTU/yr. (How do all you other guys feel)
Mexican	2 cookies		
Voltanese	2 cookies		
Liberian	2 cookies		
Ghanese	1 cookie		
Zairian	1 cookie		
Vietnamese	1 cookie		
Pakistani	1 cookie		
Ainu Indians	1/3 of a cookie crumb		
Australian Aborigine	1/3 of a cookie crumb		

This a good workshop activity, as soon people become posessive of their cookies.; and the energy the energy they use.

Energy Curriculum Materials

1. Energy and ConservationEducation 1979
   Grades 1-3, 4-6, 7-9, and 10-12
   from Energy and Man's Environment, 0224 S.W. Hamilton, Suite 301,
   Portland, Oregon 97201.

2. Science Activities in Energy
   Conservation, Chemical, Solar, Electrical, Wind
   from U.S. Department of Energy, Technical Information Center, P.O.Box 62
   Oak Ridge, TN 37830

3. Energy Conservation Activity Packet
   K-2,3, 4, 5, 6
   from Environmental Education Consultant, Curriculum Division,
   Department of Public Instruction, Grimes State Office Building
   Des Moines, Iowa 50319

4. Energy, Food, and You
   $5.00 check payable to E.S.D. 189(Educational Service District 189)
   from Energy,Food,and You Program, Washington State Office of Environmental
   Education,NW , C/O Shoreline District Office, NE 158th and 20th Ave NE ,
   Seattle, Washington 98155

5. Energy Conservation in the Home
   An Energy Education/Conservation Curriculum Guide for Home Economics Teachers
   from U.S. Department of Energy, Technical Information Center, P.O.Box 62,
   Oak Ridge, Tennessee 37830

6. Center for Alternative Technology
   Education Pack--Energy
   from National Centre for Alternative Technology, Llwygeen Quarry, Machynlleth,
   Powys, Wales

7. The Energy Challenge
   An Activity Master Program About Our Energy Past, Present,and Future for
   Grades 5 through 8
   from The Energy Challenge, Box 14306, Dayton, Ohio 45414

8. Some Things are Worth Saving- Like Energy
   Driver Education Energy Packet
   from Idaho Office of Energy, State House, Boise, Idaho 83720

9. Energy in Society
   A Resource Guide for Teachers
   from Ministry of Education, Ontario

10. Children of the Sun
   $1.50 make check payable to Environmental Education Workshop
   from Washington State Office of Environmental Education, c/o Shoreline
   District Offices, NE158th and 20th Ave., Seattle, WA 98155

11. Idaho Energy Conservation Resource Guide
   Language Arts for Grades 7-12
   from Idaho Office of Energy, Statehouse, Boise, Idaho 83720

12. Solar Energy Project: An Overview
   from Solar Energy Education Project, c/o The Bureau of Science Education,
   the State Department of Education, Albany, New York 12234

Bill Pfisterer
Energy Alternatives Program
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University of Alaska
Fairbanks, Alaska 99701